



Analytical Instrument Module (AIM) Standard Laboratory Module™ (SLM™)

General Overview of the AIM SLM

Software has been developed to automate a gas chromatography (GC) instrument as an AIM according to the Contaminant Analysis Automation (CAA) Program standards. As part of the GC AIM, a software system was developed to automate the analysis assessment of an instrument such as a GC. The software system checks that the data generated on each sample are analyzable and the instrument is in a condition to analyze the next sample successfully. Changes from baseline performance are detected and processed into symptoms, and the symptoms are input into an expert system to diagnose the cause of the changes. The system diagnoses faults arising from sample or instrument problems.

Environmental Protection Agency (EPA) Method

Automation of the SW846 8000 series and methods.

Standard Analysis Method (SAM)

This AIM applies to all SAM systems requiring a GC for the analysis step.

Advantages

The AIM enables commercially available instruments to be integrated into the Contaminant Analysis Automation (CAA) laboratories by providing standard, automated SLM control and communication. It also enables the module to assess its own status as required in a CAA SLM. The AIM identifies sample or instrument problems, which heretofore could be identified only by the intervention of a human operator.

General Description of the AIM SLM

Currently, operation of a chromatography instrument is a manual task requiring an experienced operator to examine the data to evaluate sample preparation and instrument performance. The AIM can automate the analysis assessment of a GC

instrument to check that the data generated for each sample is analyzable and that the instrument can analyze the next sample successfully. Changes from baseline performance can be detected, processed into symptoms, and these symptoms input into an expert system to diagnose the cause (problems with the sample or problems with the instrument.)

A prototype of the AIM software can be seen in operation in the CAA automated laboratory. This software is used on a GC instrument equipped with a capillary column and an electron capture detector.

The analysis assessment software consists of a signal processing system that detects symptoms of an instrument fault and an expert system that analyzes the symptoms to diagnose the fault, as illustrated in Figure 1.

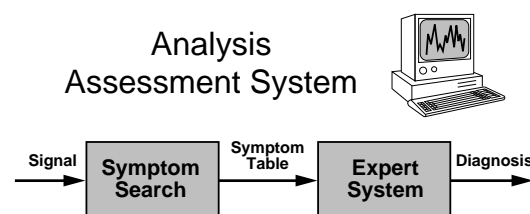


Figure 1. Modular design of the Analysis Assessment System.

Figure 2 illustrates the types of symptoms of instrument and sample faults found in each search domain. The signal processing software creates a symptom table listing the measured strength of each symptom. The symptom table is then imported into an expert system that concludes a probable cause. The expert system uses the symptom table and domain knowledge to diagnose sample and instrument faults. An expert system is required because there is no simple mapping between symptoms and causes. Rather, analysis problems typically manifest themselves with an array of symptoms. The knowledge used in the analysis assessment expert system is captured from the instrument

manufacturers troubleshooting manual, independent troubleshooting guides, previous work in this area, and consultation with experts in the field. The expert system produces a series of diagnoses weighted by the probability of each possible diagnosis. It can also produce a suggestion for remediating the problem.

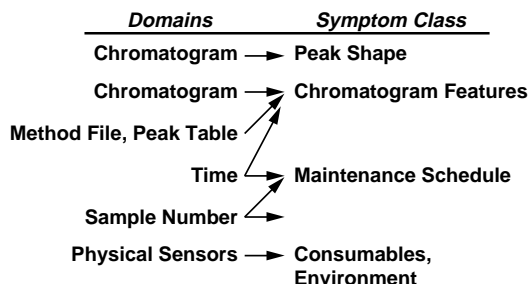


Figure 2. Domains searched for symptom classes.

Status

Software has been developed in cooperation with Varian Chromatography to control and monitor a Varian GC instrument according to the SLM standards. The software operates in conjunction with the Varian GC Star software, preserving the established user interface and instrument hardware control. This analysis assessment software is specific to a GC instrument equipped with a capillary column and electron capture detector. Development continues to expand the symptom processing and knowledge base to detect and diagnose a broad range of instrument and sample problems over a range of instrument configurations.

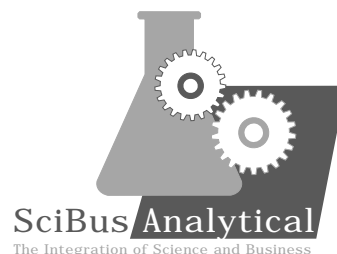
Industrial Partner

Varian Chromatography

Developers

Los Alamos National Laboratory, Sandia National Laboratories, Idaho National Laboratory, and Florida State University.

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